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PREPARATION OF FULL-FLAVOR FROZEN GRAPE JUICE CONCENTRATES

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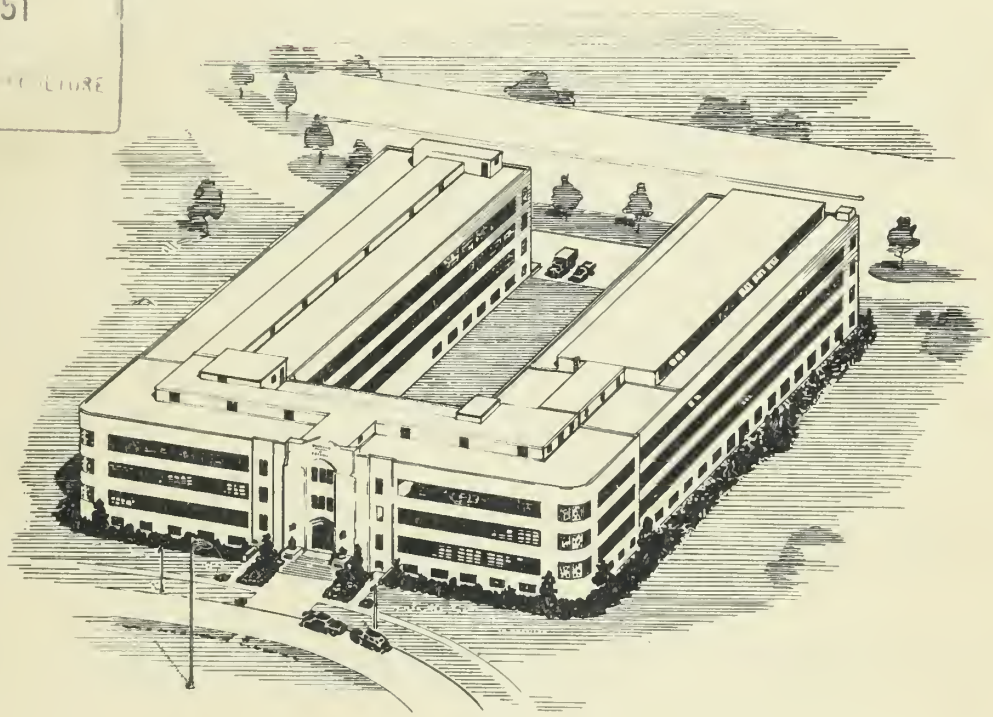

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INTRODUCTION

In 1944 a process was developed at the Eastern Regional Research Laboratory for recovering the volatile flavors of apple juice in concentrated unaltered form[1]. The publication that described this work was supplemented in April 1945 and was later superseded[2]; the later publications described improvements in the process. The volatile flavor concentrate, called apple essence, when added to highly concentrated apple juice gives a full-flavor concentrate. Since that time, the essence recovery process has been applied to the juices of other fruits[3]. Recently the application of essence recovery to the preparation of full-flavor Concord grape juice was described[4]. This was a "double essence" process, so called because it entailed the recovery of a first essence from the juice and a second essence from the condensate obtained during vacuum concentration of the stripped juice. With the current commercial development of frozen juice concentrates of about 42° Brix, studies are being made to determine how essence recovery can be employed most effectively in their production. Essence has been used in the preparation of frozen concentrates from the juice of apples grown in the Pacific Northwest[5]. Studies are currently being made at the Eastern Regional Research Laboratory on frozen apple juice concentrates containing essence and made from apples grown in the East.

This publication describes one phase of this broad program, namely, a process for preparing full-flavor frozen concentrated grape juice in which

1 Howard P. Milleville and Roderick K. Eskew, *Recovery and Utilization of Natural Apple Flavors*, U. S. Dept. Agr., Bur. Agr. and Indus. Chem. AIC-63 (Eastern Regional Research Laboratory), September 1944, with Supplement of April 1945. (Processed).

2 Howard P. Milleville and Roderick K. Eskew, *Recovery of Volatile Apple Flavors in Essence Form*, Western Canner and Packer, 38: 51-54 (October 1946).

3 Edward L. Griffin, Jr., Lyle L. Davis, Nelson H. Eisenhardt and Margaret E. Heller, *New Progress in Fruit Flavor Recovery*, Food Industries, 21: 1545-1547, 1694, 1696 (1949).

4 Richard P. Homiller, G. W. MacPherson Phillips, Roderick K. Eskew and Nelson H. Eisenhardt, *Two Pass Concentration Technic Obtains Full-Flavor Grape Juice*, Food Industries, 22: 76-78 (1950).

5 L. H. Walker, C. C. Nimmo and D. C. Patterson, *Preparation of Frozen Apple Concentrate*, Presented at Decennial Conference of Institute of Food Technologists, Chicago, May 21-26, 1950.

essence[6] is recovered and the desired degree of juice concentration is attained simultaneously. It compares the product with that prepared by a modification of the "double essence" process[4]. This work deals with Concord grapes grown in the Great Lakes and Eastern districts. The Western Regional Research Laboratory is currently studying frozen juice concentrates from western grapes.

APPARATUS

The essence recovery apparatus used in these studies was a portable experimental pilot plant unit with a capacity of 9 gallons per hour of juice when 10 percent of the juice is vaporized or 4.5 gallons when 20 percent is vaporized. It will be described in detail in a forthcoming publication[7]. Figure 1 shows a diagrammatic sketch of the apparatus.

PROCESS

Sweetened Grape Juice Concentrate: In our previous work full-flavor juice concentrates were made by stripping off in the essence recovery apparatus only that portion of the juice necessary to release the volatile aroma. This stripped juice was further concentrated by vacuum evaporation. We found, however, that with the improved evaporator design (that is, preheater and vaporizer) it is possible, at least with grape juice, to combine the steps of flavor stripping and concentration, conducting them simultaneously in the same equipment without damaging the juice by heat. This is of interest especially when a high degree of concentration of the stripped juice is not required. An example of this is frozen sweetened Concord grape juice concentrate of about 47° Brix.

Such a product is now made commercially. It is concentrated to such a degree that when diluted with three volumes of water to one of concentrate, the resulting beverage is a sweetened grape juice of about 14° Brix. The amount of sugar (sucrose) added may be about 82 percent by weight of the natural grape sugar solids in the original juice. Our work has produced a product similar to this but superior in that the grape juice component is fully equal in flavor to the original juice. This is accomplished by restoring to this juice the aroma, which in commercial concentration may be lost. In the finished product the essence : grape solids ratio is the same as that of the starting juice. Since, prior to freezing, sugar is added to the concentrated juice in an amount almost equal to the grape solids in the juice, the juice itself need not be concentrated beyond about 33-1/2° Brix. This degree of concentration can be conveniently attained in the essence recovery equipment while the volatile aroma is being recovered as essence.

6 The manufacture and use of volatile fruit flavor concentrate is subject to regulations of the Bureau of Internal Revenue. See Federal Regulations, September 27, 1949, p. 5869-5879.

7 G.W.M. Phillips, R. K. Eskew, J. B. Claffey, R. A. Davis, and R. P. Hom ller, *Esperimental Unit for Volatile Flavor Recovery*, To be published.

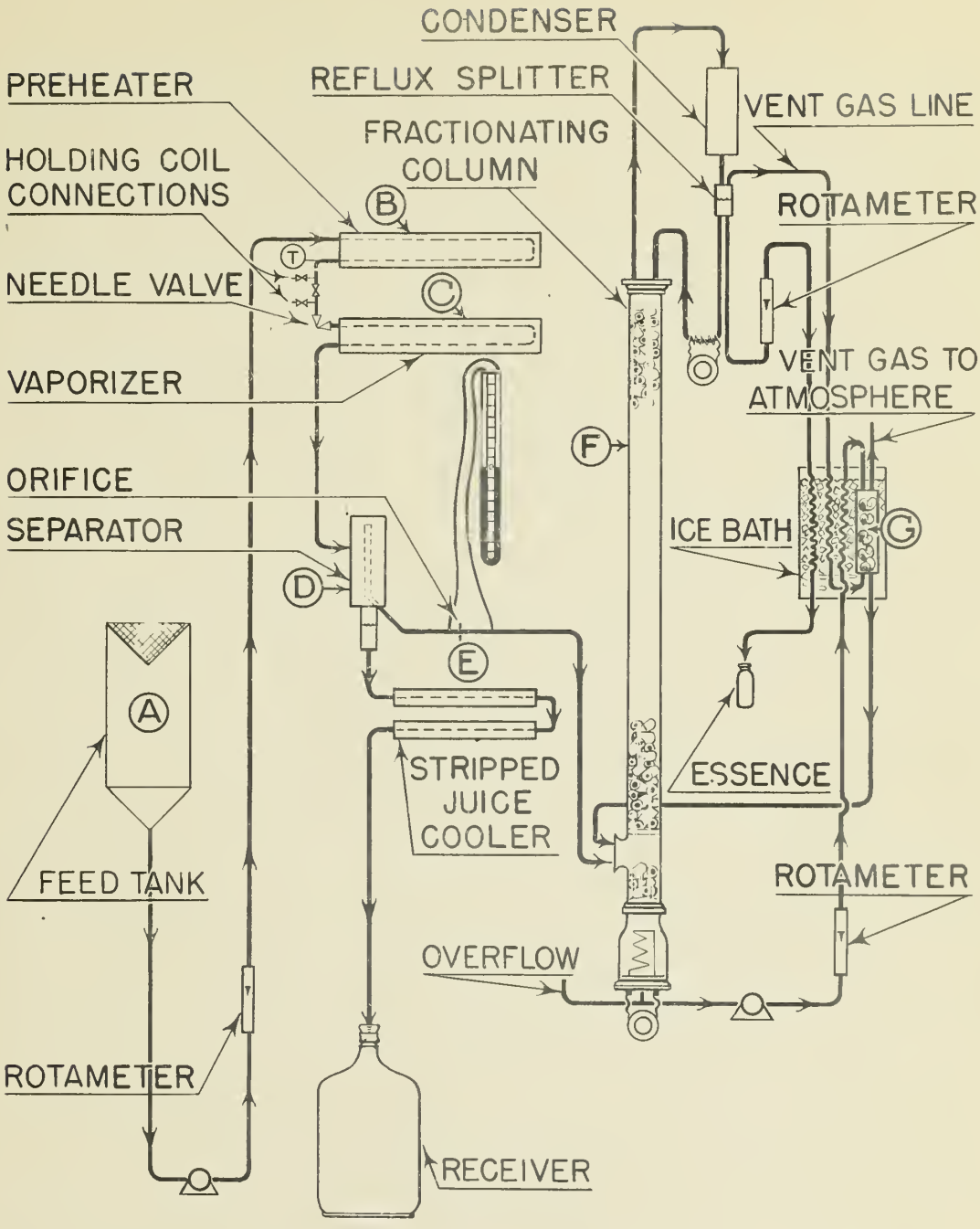

FIG. 1--EXPERIMENTAL UNIT FOR VOLATILE FLAVOR RECOVERY

The starting material can be commercial pasteurized Concord grape juice of 15.5° Brix that has been stored under the customary conditions used to precipitate the argols and then screened through a 30-mesh screen to remove the precipitate. Since the finished product is to be a frozen concentrate of 47° Brix and since 45 percent of the total solids present will be added sucrose, it is necessary to concentrate the juice itself only to 33-1/2° Brix before adding the sugar. To reach this Brix it is necessary to vaporize 59.6 percent by volume of the juice. This can be done in a single pass without heat damage to the juice because the improved design of the preheater and vaporizer requires only a short retention time. In preheater B the juice is brought to approximately 210° F., at which temperature it passes directly into evaporator C. Steam pressure in the preheater jacket is approximately one-third of a pound per square inch and in the jacket of the vaporizer C, 8 to 10 pounds per square inch. The pressures are controlled to give the desired degree of preheat temperature and of vaporization. The mixture of vapor and liquid discharging from the vaporizer C passes to separator D. The stripped and concentrated juice is rapidly cooled to room temperature in a water-jacketed cooling coil. The metered vapor containing the aroma is concentrated in the packed column F. A portion of it is drawn off as essence, and the rest is returned to the column as reflux. The essence is designated "100-fold by volume", since the rate of its draw-off is 1/100th of the feed rate of the juice. The feed rate of the juice is 1.50 gallons per hour. Vent gases from the system are scrubbed in a chilled packed column countercurrently by column bottoms previously chilled to a temperature of 40° F. The scrubbed vent gases and the column bottoms are substantially free of aroma. That part of the column bottoms not required for scrubbing the vent gas is discarded.

After the column has been operated for 2 hours on total reflux (the time previously determined by hold-up measurements as being required to produce 100-fold essence at the top of the column when the juice feed rate is 1.5 GPH), the accumulation of essence is started. The accumulated essence is added to the concentrated stripped juice. To this is added sucrose equivalent to 82 percent of the grape solids in the concentrate; thus 45 percent of the total solids in the mixture is sucrose. For example, one would add 0.023 gallon of 100-fold essence to 0.96 gallon of 33.5° Brix concentrate and then add 2.52 pounds of sucrose. After the mixture is thoroughly stirred to dissolve the sugar, the product is transferred to 6-ounce cans, quickly frozen in brine at -20° F., and stored at 0°F.

When reconstituted with three volumes of water per volume of frozen concentrate, giving a juice of 14° Brix, our product was equivalent to the starting juice in taste and aroma after sugar was added to the starting juice to the extent of 82 percent of the grape solids and it was diluted with water to 14° Brix. This and all other organoleptic evaluations were made by a taste panel skilled in the detection of slight differences in taste and aroma.

Unsweetened Concentrate. Production of an unsweetened concentrate of 47° Brix obviously requires a greater degree of vaporization during essence stripping than does a product in which part of the solids are contributed by

added sugar. Using the same apparatus, it is possible to prepare an unsweetened grape juice concentrate without damage to the flavor.

Pasteurized Concord grape juice such as was used in the process just described is fed at the rate of 1.23 gallons per hour. Sufficient steam is used in the jacket of preheater B to bring the juice to 210° F. Approximately 73 percent by volume of the juice is then vaporized in vaporizer C, the steam pressure in the jacket being adjusted and controlled to achieve this vaporization. Stripped juice, concentrated to approximately 48° Brix, flows from separator D at the rate of 0.33 gallon per hour and is quickly cooled to about 80° F.

From separator D, the vapor and its associated aroma pass to fractionating column F. After the column has been operated for 2-1/2 hours on total reflux (the time previously determined by hold-up measurements as being required to produce 100-fold essence at the top of the column when the juice feed rate is 1.23 GPH), essence is withdrawn from the reflux splitter at the rate of .0123 gallon per hour. Column bottoms are thus produced at 0.888 gallon per hour.

In operating vent gas scrubber G, column bottoms are recirculated to the scrubber at the rate of 0.8 gallon per hour. Both the vent gases and discarded column bottoms will be substantially free of aroma.

To 0.62 gallon of the cooled juice concentrate there is added 0.023 gallon of essence. This is the quantity of essence derived from the juice going into the concentrate. Thus 0.64 gallon of full-flavor unsweetened grape juice concentrate is obtained. After thorough mixing, the product is transferred to 6-ounce cans and then quickly frozen in brine at -20° F. and stored at 0° F.

On reconstitution with three parts of water to one of concentrate, which gives a juice of 14° Brix, the product was, for all practical purposes, indistinguishable in taste and aroma from the starting juice diluted with water to 14° Brix. A further comparison was made with juice of the same Brix, reconstituted from a frozen concentrate of 47° Brix made by a modification of the "double essence" process[5]. The modification consisted only in concentrating the stripped juice under vacuum to 48° Brix instead of to 68° Brix. The juices from the two types of frozen concentrate were indistinguishable. Thus, pending final data on keeping quality, we can conclude that frozen sweetened or unsweetened concentrated Concord grape juice of good quality can be made by either of the following processes. The products can be reconstituted to beverage strength, for example, 14° Brix, by adding three volumes of cold water to one volume of concentrate.

A. Vaporize in the essence unit sufficient juice to obtain in one pass the desired Brix (about 60 percent vaporization for sweetened juice and 72 percent for unsweetened juice), add the essence to the cooled juice concentrate, (and in making sweetened juice add sugar to the extent of 82 percent of the grape solids), package, and freeze.

B. Vaporize 25 percent of the juice in the essence unit and recover a first essence, complete the evaporation of the stripped juice to about 47° Brix (or 33-1/2° Brix for sweetened concentrate) at a vacuum of at least 27-1/2 inches, recover a second essence by stripping 25 percent from the condensate obtained during the vacuum evaporation, incorporate both essences in the juice concentrate (adding sugar if desired), package, and freeze.

Keeping Quality: In order to determine the keeping qualities of these frozen grape concentrates storage tests were made at 0° F. in comparison with the same product stored in dry ice (-109° F.). Triangle tests were made by a trained taste panel in which an attempt was made to determine any difference in taste or aroma between the concentrates stored at the two temperatures. Thus far (after 6 months) the panel has been unable to detect any deterioration in taste or aroma in any of the samples. They are all of good quality.

EQUIPMENT FOR COMMERCIAL OPERATION

In preparing both the sweetened and unsweetened concentrates by the process entailing simultaneous essence stripping and concentration, it was necessary to greatly reduce the rate of juice flow through the preheater and vaporizer in order not to overload the fractionating column with the vapor produced. The column was originally designed to accommodate only the vapor necessary for release of aroma and not the additional vapor incident to juice concentration. Thus a unit designed specifically to achieve stripping of aroma and concentration simultaneously should have a column much larger with respect to the evaporator than ours had. It is at once apparent, however, that there is no reason why vapor evolved in concentration of the juice beyond the point where the aromas are substantially all released need to be sent to the column. Thus a unit expressly designed for carrying out the process would have two vaporizers. The first would merely strip out the volatile flavors, which would then pass to the fractionating column. The stripped juice would then pass to the second vaporizer, also operated at atmospheric pressure, and the vapors evolved there could be discarded to the atmosphere without condensation. Such a unit could also be used for making apple juice concentrates. The second vaporizer, consisting merely of a system of tubes of small diameter and a pump for forcing the liquid through them at extremely high velocity, would be expected to cost much less than the conventional vacuum pan with its condenser and vacuum pump. It should be no more expensive to operate, as its consumption of steam would be slightly less than that of a vacuum pan, and it would require no cooling water. A further saving in costs would be obtained by using a portion of this juice vapor as the supply of steam for preheating the juice.

The question logically arises as to whether the juice could be subjected to two atmospheric evaporations without damage from heat. Further research is planned to establish this point. It seems probable, however, that this two-stage evaporation could be done without damage in the case of Concord grape juice since the total effect of heat in a properly designed unit need be no greater than the heat effect resulting from operation of the single stage evaporator far below its rated capacity, as was done in these experiments.

SUMMARY

Two processes for preparing full-flavor frozen grape juice concentrate are described. Both processes employ essence recovery by the methods developed at the Eastern Regional Research Laboratory and are applicable to both sweetened and unsweetened concentrate.